

# *A Reappraisal of Evidence for Subsistence Change at the Hane Dune Site, Marquesas Islands, French Polynesia*



MARIA SWEENEY, MICHAEL W. GRAVES, AND TERRY L. HUNT

THERE HAS BEEN A GROWING interest among archaeologists in the use of faunal materials as a means to reconstruct and interpret change in prehistoric resource economies. In the Pacific Islands evidence for this trend is indicated by a listing of some of the recent publications on this topic (e.g., Allen 1992a; Anderson 1983; Butler 1988; Dye 1990; Dye and Steadman 1990; Goto 1986; Leach and Intoh 1984; Leach et al. 1984; Masse 1986; Rolett 1989, 1992). There are several reasons why archaeologists working in Polynesia have selected faunal remains as the data for analyses of prehistoric subsistence change. First, faunal assemblages (including bone, shell, teeth, and other durable body parts) are relatively likely to be preserved in many archaeological contexts, especially in coastal settings. As a result, faunal materials are common in archaeological sites, occurring in sufficient numbers to calculate their frequency for different times and in different places. Additionally, in Polynesian archaeological sites the animals represented by faunal remains can be linked to different marine and terrestrial habitats. The animals derived from different habitats, in turn, are associated with other economic indicators such as the degree to which they may be controlled by humans, their suitability for intensification of production, and so forth. Consequently, analyses of faunal remains from archaeological sites in the Pacific may lead to conclusions about changes in prehistoric economies that are of general interest in the region and to archaeologists working elsewhere.

The growing interest in analyzing faunal assemblages has been accompanied by new methods for detecting their patterned variability and by developing interpretive models and generalizations to account for this variability (e.g., Allen 1992b; Butler 1988; Colley 1989; Grayson 1981, 1984). This paper first addresses a particular case in which the faunal assemblage from the Hane Dune site in the Marquesas Islands of central East Polynesia was analyzed and interpreted (Kirch 1973). The analysis of the Hane faunal assemblage is important in several respects. It was one of the first studies of a central East Polynesian faunal assemblage in which

Maria Sweeney is a doctoral candidate, Michael W. Graves is an associate professor, and Terry L. Hunt is an associate professor in the Department of Anthropology, University of Hawai'i at Mānoa, Honolulu, Hawai'i.

economic and ecological interpretations were made. In that study, the emphasis was on quantitative changes in the faunal assemblage from early to late Prehistoric periods, a new analytical focus in Polynesian archaeology. Along with the studies by Davidson (1967, 1969), Shawcross (1967), and Yen (1971), the research conducted by Kirch at Hane prefigured many of the subsequent processual and ecological investigations that have been the hallmark of Polynesian archaeology for the past 20 years.

In addition to its historical significance as a benchmark in Polynesian archaeology, the work by Kirch at Hane remains important. Despite some uncertainty regarding the absolute age of the earliest cultural deposits at the site, Hane has been regarded as one of the earliest Prehistoric settlements in East Polynesia (Kirch 1986; Sinoto 1966; Sinoto and Kellum 1965). The conclusion reached by Kirch (1973:37–39), that there was a shift from a marine subsistence focus to one with a substantial or dominant terrestrial focus, continues to structure archaeological research in East Polynesia (e.g., Rolett 1989, 1992). Furthermore, the temporal pattern of faunal change first proposed for Hane by Kirch became a model for subsistence change throughout Polynesia (e.g., Dye and Steadman 1990; Kirch 1980; Kirch and Yen 1982). And the suggestions by Kirch (1973:38–39) that the founders of Marquesan society had directly and indirectly affected the abundance of animal populations and the nature of the terrestrial environment have been the foundation for much subsequent archaeological research into the effects of prehistoric Polynesians on their natural environment.

Given that 20 years have passed since the publication of Kirch's original analysis of the Hane faunal assemblage, we reexamine it here. This analysis is limited to the Hane assemblage because problems attendant with recovery techniques and analytical units render other putative early East Polynesian sites such as Ha'atuatua on Nuku Hiva (Suggs 1961) uncomparable. Other sites in the region with reliable faunal data are dated to a period after A.D. 1000 or do not encompass sufficient temporal depth. We demonstrate that the Hane faunal analysis can no longer be unequivocally cited in support of the direction of subsistence change first inferred by Kirch. The purpose of this exercise is not simply to show that this research is flawed—few of us would expect any different outcome given the methodological advances in the discipline. Rather, we illustrate how zooarchaeological analytical methods are now employed in the investigation of variability in faunal assemblages. At the same time, the generalization that has its origin in Kirch's research deserves additional investigation before it can be said to be sufficiently verified for Polynesian prehistory. Finally, we address a problem rarely faced by archaeologists, that as the interpretive models we employ become increasingly fine-grained with respect to scale and level, our analytical units must match them in terms of relevance, redundancy (or sample size), and sensitivity.

#### THE HANE DUNE SITE: GENERALIZING SUBSISTENCE TRENDS FROM FAUNAL ASSEMBLAGES

The islands of central East Polynesia appear to have been the first settled after Polynesians began to explore the areas eastward of Samoa, Tonga, and Fiji. The region was probably reached sometime between the last half of the first millennium B.C. (Kirch 1986:25) and the first half of the first millennium A.D. The Hane

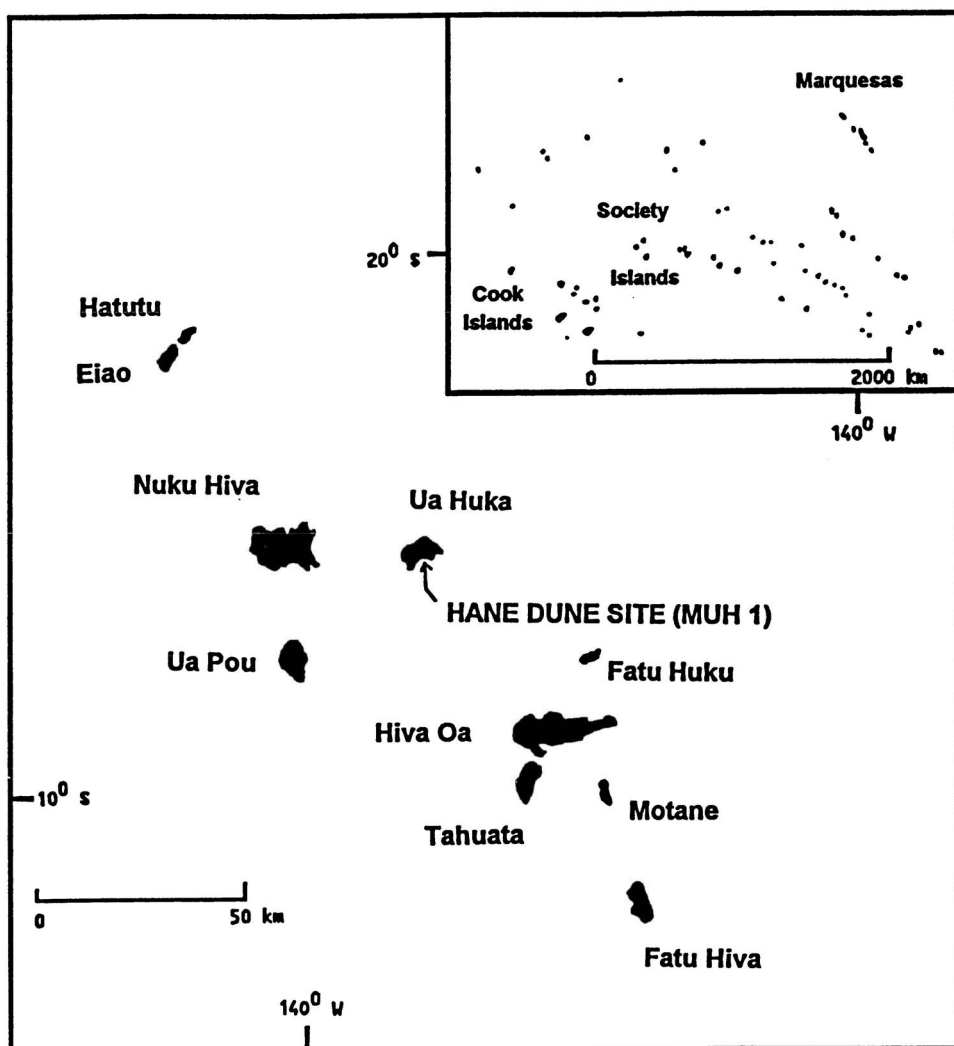


Fig. 1. Map of the Marquesas Islands showing the location of the Hane Dune site (MUH 1) on Ua Huka, with an inset of East Polynesia.

Dune site is located on the island of Ua Huka (Fig. 1) in the northern group of the Marquesas Islands. The site was first excavated by Y. Sinoto and M. Kellum in 1964 (Sinoto and Kellum 1965); based on their examination of the site's stratigraphy, they arranged its chronology into four occupation phases (Fig. 2). These phases span virtually the entire sequence of Marquesan prehistory (Sinoto and Kellum 1965:40). Associated  $^{14}\text{C}$  dates (Sinoto 1966, 1970) provide the basis for an absolute chronology for the site. These dates and their association with particular stratigraphic units have been variously interpreted (Kirch 1986; Sinoto 1966; Spriggs and Anderson 1993). Nonetheless, the separation of the site's stratigraphy into early and late components is well established.

The site encompasses an area of approximately 80 m<sup>2</sup> (Sinoto and Kellum 1965),

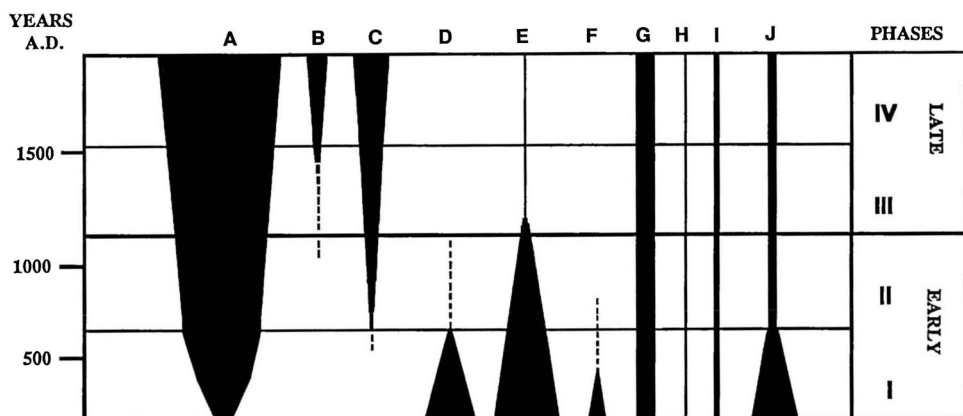


Fig. 2. Diagram (from Kirch 1973: fig. 3) depicting changing relative frequencies of the major taxa over time at the Hane Dune site. Phase numbering is from Sinoto (1966), Phase labeling and time scale are from Dye (1990). A, shell; B, human; C, pig; D, bird; E, turtle; F, small mammal; G, fish; H, Crustacea; I, sea urchin; J, chiton.

of which the excavations sampled approximately 20 m<sup>2</sup>. Kirch (1973) examined the faunal assemblage from five excavation units in the two main sections of the site. This material was later reexamined by Dye (1990). Both Kirch and Dye agree on the temporal trend represented in the faunal assemblage from Hane. They (Dye 1990:80–82; Kirch 1973:38–39) differ, however, in their interpretation of these changes.

Kirch (1973) originally identified only major taxonomic categories of fauna, including shell (separated into five taxa), bone (separated as human, pig, bird, sea mammal, turtle, and fish), sea urchin, chiton, and crustaceans. The faunal assemblages were grouped in categories of predominantly “wild” or “domestic” food remains according to the relative abundance of the categories across the four time periods represented in Figure 2. Turtle, fish, sea mammal, bird, and shell are classified as wild remains, suggesting a reliance on marine or “natural” resources, whereas pig and dog are domesticated animals, suggesting a reliance on terrestrial resources. During the earliest occupations represented at Hane, the Settlement and Developmental Phases, most of the faunal resources recovered were of marine taxa (Kirch 1973:37–38). During the Developmental Phase, Kirch (1973:38) identified a “shift in emphasis from maritime to terrestrially-oriented economy.” The final occupation layers at Hane date to the Expansion and Classic Phases and these represent the amplification and perhaps involution of the economic pattern focused on terrestrial resources (Kirch 1973:38).

The pattern of faunal change proposed by Kirch for Hane formed the basis for hypotheses of subsistence change throughout Polynesia. Kirch (1973) implied that the pattern of resource change evident in the Hane sequence pertained throughout the Marquesas. Subsequently, this view has been generalized for Polynesia (Dye and Steadman 1990). Kirch (1973:38) stated that the shift to terrestrial resources was “. . . simply the adaptation of an already highly-developed system to a local environment.” Kirch (1973:38) reasoned that a shift from wild domestic resource emphasis came with increasing numbers of people to feed over time and the loss

through predation, habitat disturbance, or a combination of the two of certain wild resources such as birds, chitons, and some fish taxa. Dye (1990), although supporting this view of resource change in the Marquesas, argued that the cause for this was not due to a pre-adaptation of Polynesians to a terrestrial economy. Following a more detailed analysis of the fish remains from Hane, Dye (1990:81–82) concluded that Marquesan fishing suffered a decline in the latest period when use of angling technology and access to marine resources were restricted by elite individuals. In his version, then, aspects of Marquesan political economy structured resource change in the archipelago.

#### TESTING A MARINE TO TERRESTRIAL SUBSISTENCE SHIFT IN PREHISTORIC MARQUESAN ECONOMY

We examine data used first by Kirch (1973) and then by Dye (1990) and question whether there is sufficient evidence to document a change from a marine-oriented to a terrestrially oriented economy for the Hane sequence in the Marquesas. In the late 1960s and early 1970s it was relatively common among archaeologists working in Polynesia to quantify fauna and other nonartifact materials by weight (e.g., Davidson 1967; Green and Davidson 1969). Kirch followed this practice in his analysis of the fauna from Hane. Dye (1990) later converted Kirch's bone weight measurements to meat weights instead of requantifying by NISP (number of identified specimens). He did this apparently because he thought that by doing so he could directly compare the relative contribution of meat per taxon (e.g., pig) by time period (e.g., Phase I) to the Marquesan diet. Because Dye used a measurement unit derived from weight, he found virtually the same pattern of subsistence change across major taxa as did Kirch previously.

The unit of measurement or counting is an important consideration in zooarchaeological analyses, because the unit chosen can differentially affect the abundance of taxa in an assemblage and for intertaxa comparisons. Despite problems of interdependence, Grayson (1984:20–24) recommended NISP as the basic counting unit for faunal material. NISP is a count of identified faunal items that have been recovered (i.e., whole or partial). MNI (minimum number of individuals) is a derived measure of taxonomic abundance. It can be estimated in several different ways based on the frequency of certain elements (e.g., the total number of mandibles), but is a function of NISP and analytic choices of assemblage aggregation. In short, Grayson (1984:90) argued that MNI provides a poor measure of taxonomic composition.

Weight is another measurement used in faunal analyses (Wing and Brown 1979:122) and, in the case of shell, can be highly correlated with NISP or MNI (Allen 1992a). However, the weight of faunal material can be differentially affected by the taxa represented, a point recognized by Kirch (1973:26) in his initial analysis although he followed the standard methodology of the time. In this case, the combined use of shell and bone weights to estimate their relative contribution to the diet is problematic because, on average, shell contributes a much greater proportion of the total body weight of the animal than does bone. The use of meat weights by Dye is thus understandable; it is a way to take into account the differences among taxa in the ratio of soft to hard body parts. Nonetheless, meat weights are similarly problematic, given the large errors associated with percentage

TABLE 1. FAUNAL DATA FROM FOUR NORTHERN MARQUESAN SITES

	PHASES					
	I		II		IV	
	WT (g)	%	WT (g)	%	WT (g)	%
Bird	1042.0	46	722.0	35	60.0	1
Shell	777.0	34	707.0	34	6089.0	86
Fish	100.0	4	401.0	19	486.0	7
Turtle	282.0	12	227.0	11	114.0	2
Pig	63.0	3	1.0	—	257.0	4
Total	2264.0		2058.0		7006.0	

estimates of skeletal to body weight and body weight to meat weight (Wing and Brown 1979:129–132), especially for pig. Moreover, as Grayson (1984:172–174) observed, there is no valid measure of estimating meat weight from assemblage bone weights on any scale other than an ordinal one.

Thus, this re-analysis is limited by the unit of measurement employed; that is, the weight of bone or shell. Nevertheless, we can examine subsistence change as measured by the weight of major taxonomic categories. Here, another problem presents itself, because in both cases percentage distributions were used to examine the faunal data. When the relative proportions of the taxonomic units are converted to percentages of the whole, we encounter the problem of a closed array. Table 1 illustrates Kirch’s (1973: tables 1–5) aggregated data from four sites (including Hane) in the northern Marquesas. The percentage entries in this table were those graphed by Kirch (1973: fig. 3), and his proposition that there was a change from a marine to a terrestrial subsistence orientation is supported by the changes in the percentage of taxa across each phase (see Fig. 2).

However, “since percentages must sum to 100, the fact that the relative abundance of one taxon increases at the same time that the relative abundance of another decreases” (Grayson 1984:19). A change in the relative abundance of one taxon over time may be a result of the closed array and not a reflection of change in absolute abundance itself. This appears to be the case here. Kirch identified a change in the relative emphasis on fishing compared with animal husbandry, although the ranked abundance of fish to pig never significantly changes. It is also evident that the weight of shell is driving the relationship between the relative abundance of the other taxa across time.

Grayson (1981, 1984) has shown the dangers of uncritically treating taxa as variables. He suggested (Grayson 1981:29) that measuring taxonomic abundances is complicated by problems with counting units and the nature of the faunal sample itself. Grayson (1984:93–96) demonstrated that faunal data are nominal to ordinal scale variables at best. We followed Grayson and converted faunal weights from Hane to rank order (i.e., ordinal) abundances. Rank order abundances can be compared across assemblages. Treating abundances as ordinal data avoids the potential closed array effect. We sacrificed *apparent* precision for greater validity in measuring faunal composition and change. Finally, we disaggregated the sites represented in Table 1 and focused solely on the assemblage from the Hane Dune site. This

TABLE 2. RANK ORDER OF TAXA BY WEIGHT FROM THE HANE DUNE SITE

	PHASES					
	I		II		IV	
	WT (g)	RANK	WT (g)	RANK	WT (g)	RANK
Bird	1004.0	1	719.9	1	60.0	6
Shell	777.0	2	521.5	3	3068.7	1
Turtle	252.0	3	215.0	5	119.5	4
Marine Inv.	249.5	4	654.2	2	168.2	3
Fish	92.5	5	340.3	4	394.2	2
Pig	63.0	6	1.0	6	62.3	5

made it possible to control for spatial, and possibly functional, effects on the procurement and deposition of faunal remains in this study.

In Table 2, the Hane Dune site faunal remains are shown, both by weight and rank of each taxon for the three phases represented in excavation units of areas A and B. Bird ranks as the most abundant taxon for the first two phases, but falls to the lowest rank in the final phase. As originally suggested by Kirch (1973) and argued subsequently by Steadman (1989) and Rolett (1992), the marked reduction of bird in the later period of Marquesan prehistory is likely to represent the extinction or extirpation of avian taxa as a result of human-induced change. Only avifauna show such a dramatic change in both weight and rank order over time at Hane. All four marine taxa—shell, marine invertebrates, fish, and turtle—are dominant across the three temporal phases. Even if we removed data on shellfish from Table 2 because the ratio of shell to body weight is much different than that for bone materials, the remaining marine resources would continue to be the most consistent and common taxa across the phases represented at the site. Pig, the marker of terrestrial exploitation and indicator of agricultural (i.e., domesticated) production, never ranks higher than fifth in weight among the six taxa represented. In terms of rank order abundance, we conclude that marine resource exploitation is the most prevalent and persistent pattern during all the time periods represented at the site. At Hane, with the exception of bird, there is no evidence among the animal taxa for a qualitative shift in the subsistence economy. Certainly, the faunal record does not point to the late Prehistoric at Hane as indicative of “intensive agriculture and animal husbandry” (Kirch 1973:38)—a conclusion drawn from ethnohistoric sources. Based on the faunal assemblages represented at Hane, marine resources composed an important, stable part of the subsistence economy of the population of this area.

If the major taxa (excepting bird) show no shift over time in their rank order abundances, is it possible to identify a shift within a major taxon? Dye (1990:73–75) explored this possibility and suggested that within the fish assemblage from Hane there is evidence of a dramatic shift from pelagic to inshore fishing. This shift, in turn, is linked to the more general change in subsistence practices from marine to terrestrial resources (Dye 1990:75–76).

Dye's analysis of the fish remains departed in several respects from Kirch's earlier study. Nearly 500 elements were identifiable by Dye, using the Bishop

Museum’s reference collection. These elements were assigned to 18 fish families among the Hane assemblage, in contrast to the six families first identified by Kirch. Dye separated the Hane fish assemblage into two time periods: early (including Phases I and II), and late (including Phases III and IV).

Dye imposed two divisions of marine habitat—inshore and offshore or pelagic—on the fish taxa identified in the assemblage (see Table 3 for a summary of his data from Hane). The distribution of inshore and offshore fish across the two time periods was offered as evidence that offshore fishing suffered a startling decline in the later time period. Greater effort, Dye argued (1990:75), was devoted to inshore fishing. This shift in habitat use is tied to Dye’s analyses of both fishhooks (1990:72–73) and the major animal taxa (1990:76). He argued that there is a correspondence among the analyses with the dramatic loss of offshore fishing and the reduction of birds, resulting in less subsistence diversity. The shift toward inshore fishing and the increase in pigs is then interpreted as greater emphasis on terrestrial resources. Thus, the fish assemblage is viewed as another indicator of the overall change in subsistence practices identified previously.

There are, however, several aspects of the fish analysis that bear closer inspection. The excavation of Hane was undertaken with a large mesh screen, and several studies (Butler 1988; Gordon 1993; Payne 1972; Shaffer 1992; Thomas 1969) have demonstrated the effects of screen size on recovery of faunal remains. Dye’s analyses of the Marquesan fish bone utilized assemblages from three sites and this adds spatial (and possibly, functional) variability to his results. The assignment of fish families to particular habitats is also problematic, because fish can move across

TABLE 3. NUMBER OF IDENTIFIED SPECIMENS (NISP) AND RANK ORDER OF THE HANE DUNE FISH

TAXA	EARLY PERIOD		LATE PERIOD		DYE’S HABITAT
	NISP	RANK	NISP	RANK	ZONE CLASSIFICATION
Serranidae	64	2	14	2	Inshore
Elasmobranchii	82	1	14	2	Pelagic
Carangidae	55	3	1	6	Pelagic
Lutjanidae	11	7	2	5	Inshore
Acanthuridae	9	8	9	3	Inshore
Labridae	7	10	2	5	Inshore
Scombridae	14	5	2	5	Pelagic
Holocentridae	6	11	1	6	Inshore
Diodontidae	5	13	43	1	Inshore
Lethrinidae	12	6	2	5	Inshore
Belonidae	4	14	—		Pelagic
Scaridae	8	9	4	4	Inshore
Kyphosidae	6	12	—		Inshore
Polynemidae	16	4	—		Inshore
Mullidae	1	16	1	6	Inshore
Anguilliformes	2	15	2	5	Inshore
Ostraciidae	—		1	6	Inshore
Cirrhitidae	—		1	6	Inshore

$R_s = 1.54$ , sig. = 0.14  
Excluding Diodontidae:  $R_s = 2.08$ , sig. = 0.05



habitats depending on age and species. Rolett (1989:204) conducted a limited field study to collect information on Marquesan fishing strategies and documented that most fish families can be procured from either the inshore or offshore zones depending on the particular species of fish, the time of day, or the time of year. For example, Serranidae, Lethrinidae, and Lutjanidae, which were classified as inshore fish by Dye (1990:74), could be obtained from the pelagic zone in the Marquesas. Nor did Dye consider how the abundance of Diodontidae (spiny pufferfishes) in the later period might be the result of differential preservation and the numerous and highly distinctive (and thus identifiable) spines from members of this family, a point addressed by Kirch and Dye (1979) and illustrated by Allen (1992*b*: table 1). Because diodons fall into the inshore category, and because Dye calculated percentages of taxa by time period, their abundance in later assemblages forces offshore fish taxa to be represented in lower relative frequency.

Again, it is possible to reexamine the Hane fish assemblage data presented by Dye and to determine if there is sufficient evidence to warrant the inference that there was a shift in fish taxa represented. Because of the problems in using percentages to compare NISP values for the fish (in Table 3) between time periods, we rank-ordered the taxa by abundance. After removal of the diodons, the orders produced by this procedure are highly correlated. This suggests that there is no evidence of a qualitative difference between early and late periods at Hane in the procurement of fish from different habitats. Measures of fish richness show comparable results. For instance, virtually the same number (15 and 16) of families of fish are represented in both periods; similarly, there are 11 taxa of inshore fish in both periods. Given the predictable sample size effect on number of taxa (Grayson 1984) and that the late-period fish assemblage is only one-half the size of the early period assemblage, with increased sample size, the later assemblages might actually

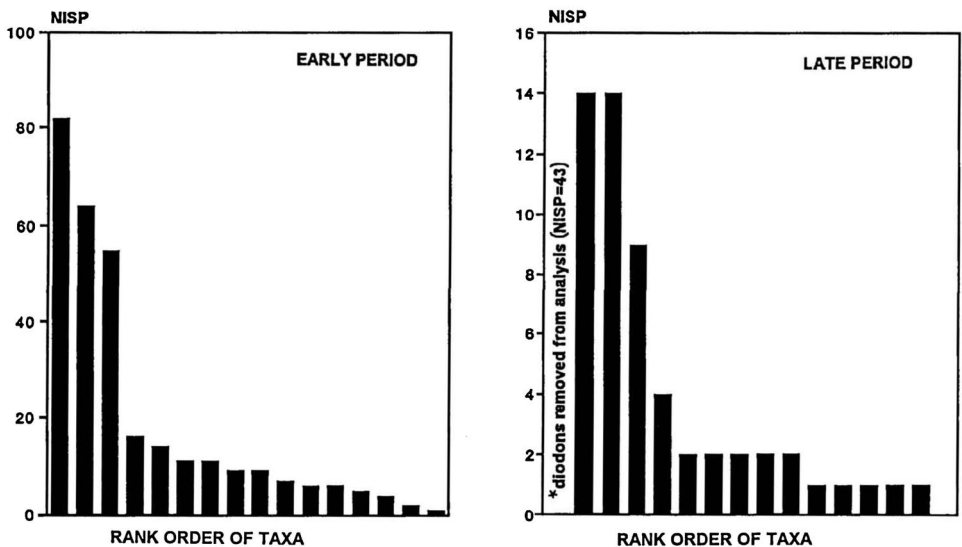


Fig. 3. NISP of fish taxa identified by Dye (1990: table 1) for the Hane Dune site, in rank order of abundance for early and late periods.

contain more taxa than early assemblages. Only one offshore fish family (Belontiidae) is lost between early and later periods at Hane. The low rank of this family in the early period suggests that this could be the problem of sampling a rare taxon. When fish taxa from the two time periods are compared in terms of evenness (Fig. 3), they also show similar patterns. There are a few taxa that occur commonly, and the remaining taxa are less abundant. Although this pattern could be interpreted as an indication of resource specialization, it could also be the result of screening bias, because Gordon (1993) showed that larger screen sizes tend to produce skewed taxa representations suggestive of specialized procurement. There is no evidence to suggest a shift in diversity from offshore and inshore taxa over time.

Thus, other than the difference in the abundance of Diodontidae, similar fish taxa dominate the Hane assemblage over time. The assertion of a significant change in fish exploitation cannot be established based on current evidence from the site.

### CONCLUSION

The archaeological site at Hane has provided important information about central East Polynesian prehistory. That it has done so and continues to do so is due in part at least to the quantity and quality of the archaeological data recovered and recorded from the site. One of the conclusions we draw from this reanalysis of its faunal assemblage, supported by Kirch (pers. comm., 1992), is the need to study the complete Hane faunal assemblage in detail, drawing upon improved reference collections and new analytic strategies. Much remains to be learned from these materials about the evolution of animal resource use in the Marquesas.

Yet, as we hope to have demonstrated here, better reference collections and identification of faunal materials by themselves will not resolve problems pertaining to subsistence change in Polynesia. Thus, this paper has also raised the significance of analytic methods in faunal studies. Grayson's (e.g., 1984) important work has changed quantitative approaches—highlighting the role of shifts in method since Kirch's early analysis.

We conclude that the wild to domestic transition argued for Hane subsistence is not supported by reanalysis. We also note that because of the way faunal remains were originally recovered, measured, and reported, it was difficult to ask research questions supported by recent faunal studies. Nonetheless, excavation and analysis of the faunal remains with current standards would likely yield the same pattern.

Except for the loss of birds over time at Hane—a trend first identified by Kirch (1973:37)—there is no evidence for substantial change in the use of subsistence resources. The change in the abundance of birds has now been documented elsewhere in the Marquesas and Polynesia (e.g., Dye and Steadman 1990; Olsen and James 1982, 1984; Rolett 1992; Steadman 1989, 1991; Steadman and Kirch 1990). This pattern is well documented, although we observe that archaeologists and avian biologists have yet to fully describe the onset and duration of this process, nor do we completely understand the proximate mechanisms leading to the reduction of birds in Polynesian archaeological sites.

The persistent structure of resource use at Hane suggests that in some locations subsistence may have been relatively stable over long periods of time. This result, although probably surprising to some archaeologists, is consistent with our inter-

pretation of research by Allen (1992a) in the Cook Islands; Gordon (1992) in Hawai'i; and Nagaoka (1993) and Kirch and Hunt (1993) in Manu'a, Samoa. The similarity among these results, especially because faunal assemblages have been analyzed with questions of change in mind, suggests that stable patterns of faunal resource use may be more common, rather than the exception in Polynesian prehistory. Clearly, Polynesian subsistence change is in need of additional investigation, both with respect to its theoretical terms and its substantive dimensions.

On the question of quantitative subsistence change in Polynesia, archaeologists must address problems attendant with recovery, analytical units and measurement, and quantification of faunal assemblages. At present, our interpretations often exceed the ability of current approaches to resolve, or unambiguously detect, patterns of food procurement variability. Under such conditions, it can be relatively easy to let predilections of change take on much of the interpretive and empirical burden. Alternatively, and by necessity we would argue, archaeologists must identify patterns of faunal variability that are recurrent and robust if they are to document less dramatic changes. Only by implementing such a research strategy can we begin to make the most effective use of the faunal assemblages available for analysis and thus contribute to the resolution of the perennial problem in Polynesian prehistory regarding change and stability in subsistence practices.

#### ACKNOWLEDGMENTS

This paper was first presented by M. S. at the 57th Annual Meetings of the Society for American Archaeology in a symposium organized by E. A. Gordon and L. Nagaoka, entitled "Methodological Issues in Subsistence and Environmental Change in Oceania." A number of individuals have since commented on this paper, including V. Butler, E. Gordon, D. K. Grayson, P. V. Kirch, L. Nagaoka, B. Rolett, K. Stark, and Y. Sinoto. Special thanks to M. Allen, who read, edited, and offered many useful suggestions that were incorporated into this version. We thank them for helping to improve its coherency, consistency, and fairness. The errors remain ours alone.

#### REFERENCES

- ALLEN, M. S.  
 1992a *Paleoenvironment and Human Subsistence on Aitutaki, Cook Islands*, Ph.D. diss. Department of Anthropology, University of Washington, Seattle.  
 1992b Temporal variation in Polynesian fishing strategies: The southern Cook Islands in regional perspective. *Asian Perspectives* 31:183-204.
- ALLEN, M. S., AND D. W. STEADMAN  
 1990 Excavations at the Ureia Site, Aitutaki, Cook Islands: Preliminary results. *Archaeology in Oceania* 25:24-37.
- ANDERSON, A.  
 1983 Faunal depletion and subsistence change in the early prehistory of southern New Zealand. *Archaeology in Oceania* 18:1-10.
- BUTLER, V. L.  
 1988 Lapita fishing strategies: The faunal evidence, in *Archaeology of the Lapita Cultural Complex: A Critical Review*: 99-115, ed. P. V. Kirch and T. L. Hunt. Thomas Burke Memorial Washington State Museum Research Report 5. Seattle.
- COLLEY, S.  
 1989 The analysis and interpretation of archaeological fish remains. *Archaeological Method and Theory* 2:207-253.

DAVIDSON, J. M.

- 1967 Midden analysis and the economic approach in New Zealand archaeology. *Records of the Auckland Institute and Museum* 6(3):203–228.
- 1969 Excavation of a coastal midden deposit, Su-Lo-1, in *Archaeology in Western Samoa*, vol. 1:224–252. Bulletin of the Auckland Institute and Museum.

DYE, T.

- 1990 The causes and consequences of a decline in the prehistoric Marquesan fishing industry, in *Pacific Production Systems: Approaches to Economic Prehistory*: 70–84, ed. D. E. Yen and J. M. J. Mummery. Canberra: Australian National University.

DYE, T., AND D. W. STEADMAN

- 1990 Polynesian ancestors and their animal world. *American Scientist* 78:207–215.

GORDON, E. A.

- 1992 Diversity and the analysis of subsistence: A case from Hawaii. Manuscript on file. Department of Anthropology, University of Hawai'i, Honolulu.
- 1993 Screen size and differential faunal recovery: A Hawaiian example. *Journal of Field Archaeology* (in press).

GOTO, A.

- 1986 Prehistoric Ecology and Economy of Fishing in Hawaii: An Ethnoarchaeological Approach, Ph.D. diss. Department of Anthropology, University of Hawai'i, Honolulu.

GRAYSON, D. K.

- 1981 A critical view of the use of archaeological vertebrates in paleoenvironmental reconstruction. *Journal of Ethnobiology* 1(1):28–38.
- 1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. New York: Academic Press.

GREEN, R. C., AND J. M. DAVIDSON, EDS.

- 1969 *Archaeology in Western Samoa*, vol. 1. Bulletin of the Auckland Institute and Museum, 6.

KIRCH, P. V.

- 1973 Prehistoric subsistence patterns in the northern Marquesas Islands, French Polynesia. *Archaeology and Physical Anthropology in Oceania* 8:24–40.
- 1980 Polynesian prehistory: Cultural adaptation in island ecosystems. *American Scientist* 68:39–48.
- 1986 Rethinking East Polynesian prehistory. *Journal of the Polynesian Society* 95:9–40.

KIRCH, P. V., AND T. S. DYE

- 1979 Ethno-archaeology and the development of Polynesian fishing strategies. *Journal of the Polynesian Society* 88:53–76.

KIRCH, P. V., AND T. L. HUNT

- 1993 Synthesis and interpretation, in *The To'aga Site: Three Millennia of Polynesian Occupation in the Manu'a Islands, American Samoa*: in press, ed. P. V. Kirch and T. L. Hunt. Contributions of the University of California Research Facility, Berkeley.

KIRCH, P. V., T. L. HUNT, L. NAGAOKA, AND J. TYLER

- 1990 An ancestral Polynesian occupation site at To'aga, Ofu Island, American Samoa. *Archaeology in Oceania* 25:1–15.

KIRCH, P. V., AND D. E. YEN

- 1982 *Tikopia: The Prehistory and Ecology of a Polynesian Outlier*. B. P. Bishop Museum Bulletin 238.

LEACH, B. F., AND M. INTOH

- 1984 An archaeological fishbone assemblage from the Vitaria Site, Rurutu, Austral Islands. *Journal de la Société des Océanistes* 78:75–77.

LEACH, B. F., M. INTOH, AND I. W. G. SMITH

- 1984 Fishing, turtle hunting, and mammal exploitation at Fa'ahia, Huahine, French Polynesia. *Journal de la Société des Océanistes* 79:183–197.

MASSE, W. B.

- 1986 A millennium of fishing in the Palau Islands, Micronesia, in *Traditional Fishing in the Pacific: Ethnographical and Archaeological Papers from the 15th Pacific Science Congress*: 85–117. Pacific Anthropological Records 17. Honolulu: Bishop Museum.

- NAGAOKA, L.  
1993 Faunal assemblages from the To'aga Site, in *The To'aga Site: Three Millennia of Polynesian Occupation in the Manu'a Islands, American Samoa*; in press, ed. P. V. Kirch. and T. L. Hunt. Contributions of the University of California Research Facility. Berkeley.
- OLSEN, S. L., AND H. F. JAMES  
1982 Fossil birds from the Hawaiian Islands: Evidence for wholesale extinction by man before Western contact. *Science* 217:633-635.  
1984 The role of Polynesians in the extinction of the avifauna of the Hawaiian Islands, in *Quaternary Extinctions: A Prehistoric Revolution: 768-780*, ed. P. S. Martin and R. G. Kline. Tucson: University of Arizona Press.
- PAYNE, S.  
1972 Partial recovery and sample bias: The results of some sieving experiments, in *Papers in Economic Prehistory*: 49-64, ed. E. S. Higgs. Cambridge: Cambridge University Press.
- ROLETT, B. V.  
1989 *Hananiai: Changing Subsistence and Ecology in the Prehistory of Tahuata (Marquesas Islands, French Polynesia)*, Ph.D. diss. Department of Anthropology, Yale University, New Haven, Conn.  
1992 Faunal extinctions and depletions linked with prehistory and environmental change in the Marquesas Islands (French Polynesia). *Journal of the Polynesian Society* 101:86-94.
- SHAFFER, B. S.  
1992 Quarter-inch screening: Understanding biases in recovery of vertebrate faunal remains. *American Antiquity* 57:129-136.
- SHAWCROSS, W.  
1967 An investigation of prehistoric diet and economy on a coastal site at Galatea Bay, New Zealand. *Proceedings of the Prehistoric Society* 75:287-303.
- SINOTO, Y. H.  
1966 A tentative prehistoric cultural sequence in the northern Marquesas Islands, French Polynesia. *Journal of the Polynesian Society* 75:286-303.  
1970 An archaeologically based assessment of the Marquesas Islands as a dispersal center in East Polynesia, in *Studies in Oceanic Culture History*, vol. 1:105-132, ed. R. C. Green and M. Kelly. Pacific Anthropological Records 11. Honolulu: Bishop Museum.
- SINOTO, Y. H., AND M. J. KELLUM  
1965 Preliminary report on excavations in the Marquesas Islands, French Polynesia. Mimeo. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.
- SPRIGGS, M., AND A. ANDERSON  
1993 Late colonization of East Polynesia. *Antiquity* 67: 200-217.
- STEADMAN, D. W.  
1989 Extinction of birds in East Polynesia: A review of the record, and comparisons with other Pacific Island groups. *Journal of Archaeological Science* 16:177-205.  
1991 Extinct and extirpated birds from Aitutaki and Atiu, southern Cook Islands. *Pacific Science* 45:325-347.
- STEADMAN, D. W., AND P. V. KIRCH  
1990 Prehistoric extinction of birds on Mangaia, Cook Islands, Polynesia. *Proceedings of the National Academy of Sciences* 8:9605-9609.
- SUGGS, R. C.  
1961 *The Archaeology of Nuku Hiva, Marquesas Islands, French Polynesia*. Anthropological Papers of the American Museum of Natural History 43, part 1. New York.
- THOMAS, D. H.  
1969 Great Basin hunting patterns: A quantitative method for treating faunal remains. *American Antiquity* 34:392-401.
- WING, E. S., AND A. B. BROWN  
1979 *Paleonutrition: Method and Theory in Prehistoric Foodways*. New York: Academic Press.
- YEN, D. E.  
1971 The development of agriculture in Oceania, in *Studies in Oceanic Culture History*, vol. 2:1-12, ed. R. C. Green and M. Kelly. Pacific Anthropological Records 12. Honolulu: Bishop Museum.

## ABSTRACT

The faunal assemblage from the Hane Dune site in the Marquesas Islands serves as one of the best-documented cases of Prehistoric subsistence change in Polynesia. Reanalysis of the data using more reliable quantitative techniques indicates that there is insufficient evidence to identify a qualitative shift from a marine-oriented to a terrestrially focused economy. With the exception of the loss of birds over time, the Hane faunal assemblage is dominated by marine taxa over time. Stability rather than dramatic change appears to be the subsistence trend at Hane. This suggests that archaeologists may want to reconsider their analyses and interpretations of subsistence patterns in Polynesia. **KEYWORDS:** faunal analysis, subsistence change, quantitative methods, Marquesas Islands, French Polynesia.